

WHAT IS CLAIMED IS:

1. A method of controllably moving material comprising the steps of:
providing a microchannel device that includes a substrate having first and
5 second channels disposed therein;
coupling said first and second channels with a membranous material that
is characterized by an ability to conduct electrical current while inhibiting bulk
material flow therethrough;
providing a flow of a first material through said first channel; and
10 controlling the flow of said first material in said first channel by
selectively applying an electric potential across said first and second channels and
said membranous material.
2. A method as set forth in Claim 1 wherein the step of providing the
15 microchip comprises the step of forming the microchip such that the second
channel has a portion that is adjacent to the first channel in substantially parallel
relation thereto and wherein the first and second channels are coupled by
interposing the membranous material between said first and second channels.
- 20 3. A method as set forth in Claim 2 wherein the step of controlling the flow
of the first material in said first channel comprises the step of applying the
electric potential such that it inhibits the flow of the first material beyond the
portion of said first channel adjacent to said portion of said second channel,
whereby the concentration of the first material is increased in said first channel.
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4. A method as set forth in Claim 1 where the membranous material is a
porous glass.
5. A method as set forth in Claim 1 where the membranous material is a
30 polymeric material.

6. A method as set forth in Claim 1 wherein the controlling step comprises the steps of applying a first electric potential to a first end of the first channel and applying a second electric potential to the second channel so as to transport the material from the first end of the first channel to a second end of the first channel.

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7. A method as set forth in Claim 1 wherein the controlling step comprises the step of applying a first electric potential to a first end of the first channel and applying a second electric potential to the second channel so as to transport material from a second end of the first channel to the first end of the first channel.

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8. A method of controllably moving material comprising the steps of:
providing a microchannel device that includes a substrate having first, second, and third channels disposed therein, the first, second, and third channels communicating at a channel intersection, said second channel containing a
15 membranous material that is characterized by an ability to conduct electrical current while inhibiting bulk material flow therethrough; and

providing a flow of a first material from said first channel into said third channel by applying a first electrical potential to said first channel and a second electrical potential to said second channel through said membranous material.

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9. A method as set forth in Claim 8 wherein the membranous material is a polymeric gel.

10. A method as set forth in Claim 8 wherein the membranous material is a
25 polyacryllymide gel.

11. A method of controllably moving material comprising the steps of:
providing a microchip that includes at least first, second, third, and fourth
channels formed in a substrate and first, second, third, and fourth reservoirs in
30 fluid communication with said first, second, third, and fourth channels, said first, second, third and fourth channels communicating at a first intersection, and each

having an electrical contact formed between said reservoirs and said first intersection by a membranous material that is characterized by an ability to conduct electrical current while inhibiting bulk material flow therethrough;

5 providing a flow of a first material from said first channel into said third channel and a flow of a second material from said second channel into said third and fourth channels by applying a first electrical potential between said first reservoir and the first electrical contact and a second electrical potential between said second reservoir and the second electrical contact; and then

10 providing a flow of the first material from said first channel into said fourth channel by lowering the second electrical potential relative to the first electrical potential.

12. A method as set forth in Claim 11 further comprising the step of raising the second electrical potential to its initial value, whereby the flow of the first material only to the third channel is restored.

13. A method of purifying a material comprising the steps of:

20 providing a microchip that includes a substrate having at least first and second channels disposed therein, said second channel having a portion that is adjacent to the first channel in substantially parallel relation thereto;

coupling said first and second channels with a membranous material that is characterized by an ability to conduct charged particles or ions while inhibiting bulk material flow therethrough;

25 providing a first material in said first channel;

providing a second material in said second channel; and

applying an electrical potential between said first channel and said second channel such that particles or ions in the first material are transported through said membranous material into said second channel.

30 14. A method as set forth in Claim 13 wherein the first material contains a mixture of ions and molecules of a distribution of sizes and upon applying said

electrical potential, small ions in the first material are transported from the first channel to the second channel in preference to larger ions and molecules in the first material.

5 15. A method as set forth in Claim 13 wherein no electrical potential is applied between the first and second channels, and ions or molecules diffuse through said membranous material from the first channel to the second channel.

10 16. A method as set forth in Claim 13 comprising the steps of:
 providing a third channel in said substrate, said third channel having a portion that is adjacent to the first channel in substantially parallel relation thereto;
 coupling said first and third channels with the membranous material;
 providing a third material in said third channel; and
15 applying the electrical potential between said first channel and said third channel such that particles or ions in the first material are transported through said membranous material into said third channel.

20 17. A method as set forth in Claim 16 wherein a first potential is applied to the first channel, a second potential is applied to the second channel and a third potential is applied to the third channel such that ions of one polarity are transported from the first channel to the second channel and ions of an opposite polarity are transported from the first channel to the third channel.

25 18. A method as set forth in Claim 16 wherein no electrical potential is applied between the first, second, and third channels, and ions or molecules diffuse through said membranous materials from the first channel to the second and third channel.

30 19. A method for pumping a material through a channel comprising the steps of:

providing microchannel device that includes a substrate having first and second channels disposed therein, said first and second channels being in fluid communication at a channel intersection and containing a first fluidic material;

5 providing a membranous material in the first channel adjacent to the channel intersection; inducing a hydraulic pressure in the second channel by applying an electrical potential between the first and second channels.

20. A method as set forth in Claim 19 comprising the steps of:

10 providing a third channel that is in fluid communication with the first and second channels at the channel intersection;

providing a second membranous material in the third channel adjacent to the channel intersection; and

inducing the hydraulic pressure in the second channel by applying the electrical potential between the first and third channels.

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21. A method of transporting material in a channel comprising the steps of:

providing a microchannel device that includes a substrate having a channel formed therein, said channel having an inlet, said channel containing a first material that provides electroosmotic mobility;

20 providing first and second electrical contacts in said channel; and

transporting said first material through said first channel by applying an electrical potential between said first and second contacts.

22. A method as set forth in Claim 21 wherein said first and second contacts
25 are formed of a membranous material.

23. A method as set forth in Claim 21 comprising the steps of:

bringing the inlet of said channel into fluid communication with a reservoir containing a second material;

30 moving the first material by applying the electric potential between said first and second electrodes for a time sufficient to form a column of the second

material in the channel; and

removing the electrical potential from the first and second electrodes when a leading edge of said column is adjacent to said first electrode.

5 24. A method as set forth in Claim 21 comprising the further steps of:

providing third and fourth electrical contacts in said channel;

moving the volume of said second material by applying the electrical potential between the second and third electrodes until said volume of second material is positioned at said second electrical contact; and then

10 moving the volume of second material by applying the electrical potential between the third and fourth electrodes until said volume of second material is positioned at said third electrode.

25. A method of mixing at least two materials comprising the steps of:

15 providing a microchip that includes a substrate having first, second, and third channels disposed therein, said first, second, and third channels being in fluid communication at a channel intersection;

providing first, second, and third electrical contacts in said third channel at spaced locations along said third channel;

20 moving a first material through the first channel into the third channel adjacent to the first, second, and third electrodes by applying an electrical potential between the first channel and the third channel;

moving a second material through the second channel into the third channel adjacent to the first, second, and third electrodes by applying the electrical potential between the second channel and the third channel; and

25 applying electrical potentials between the first and second electrodes and between the second and third electrodes, such that the first and second materials are circulated in said third channel, whereby the first and second materials are mixed together.

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26. A device for the manipulation of liquid phase materials, comprising:

a substrate;
a first channel formed on said substrate;
a second channel formed on said substrate;
a membranous material disposed between said first and second channels,
5 said membranous material being characterized by an ability to conduct electrical
current while inhibiting bulk material flow therethrough; and
a source of electrical potential operatively connected between said first
and second channels for inducing electrokinetic transport of a fluid material in
said first channel.

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27. A device as set forth in Claim 26 wherein said first channel has an upper
portion and a lower portion and the second channel has a portion that is adjacent
to the lower portion of the first channel in substantially parallel relation thereto.

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28. A device for the manipulation of liquid phase materials, comprising:
a substrate;
first and second channels formed on said substrate;
a reservoir in fluid communication with said first and second channels;
and

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a source of electrical potential operatively connected between said first
and second channels for inducing electrokinetic transport of a fluid material from
said reservoir into said second channel.

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29. A device as set forth in Claim 28 wherein said first channel contains a
membranous material, said membranous material being characterized by an
ability to conduct electrical current while inhibiting bulk material flow
therethrough.

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30. A device for the manipulation of liquid phase materials, comprising:
a substrate;
first, second and third channels formed on said substrate, said first,

second, and third channels being in fluidic communication at a channel junction;
a membranous material disposed in said second channel, said
membranous material being characterized by an ability to conduct electrical
current while inhibiting bulk material flow therethrough; and

5 a source of electrical potential adapted to be selectively connected to said
first and second channels for inducing transport of a material in said first and
third, and fourth channels.

31. A device as set forth in Claim 30 wherein the substrate is formed of a gas-
10 permeable material.

32. A device as set forth in Claim 31 further comprising a nonporous
coverplate, formed of an electrically insulating material and affixed to said
substrate and a metallic electrode formed on said nonporous plate adjacent to said
15 fourth channel, whereby electrical conduction can occur between said electrode
and said fourth channel.

33. A device for the manipulation of liquid phase materials, comprising:
a substrate formed of a gas permeable material;
20 a first channel disposed in said substrate and containing a first material;
a coverplate containing a spatially defined electrically conducting
material so as to form an electrode;
said coverplate and said substrate being mated together such that the
coverplate seals the first channel and the electrode makes electrical contact with
25 said channel; and
a source of electrical potential operatively connected between said first
channel and said electrode so as to transport said first material through said first
channel.

30 34. A device as set forth in Claim 33 wherein the coverplate is made of a gas
permeable material.

35. A device as set forth in Claim 33 wherein the electrode is formed on the substrate.